EXAMPLE OF PUBLIC GOODS-TYPE: ALTERNATIVE DAM FAILURE RISK ASSESSMENT EXCERPT

Appendix 4-3

Standard Portion: Mitigation Strategy

Commonwealth of Kentucky Enhanced Hazard Mitigation Plan: 2013 Version

Kentucky Emergency Management (KYEM)
University of Kentucky, Martin School of Public Policy and Administration
Hazard Mitigation Grants Program (UK-HMGP)

Kentucky Energy and Environment Cabinet, Department for Natural Resources,
Division of Water (KDOW)
Watershed Management Branch

Kentucky's Division of Water recently completed a federally-funded project that augments Kentucky's current ability to assess the risk that would result from one of thousands of the Commonwealth's dams if one of them failed. Again, such a project, undertaken by one of the Commonwealth's executive agencies, illustrates the Commonwealth's pursuit of Public Goods-Type *mitigation actions. Kentucky consistently has been able to provide apt and cutting-edge risk analysis thanks largely to the work of the University of Louisville's Center for Hazards Research and Policy Development (CHR) and to the support of Kentucky Emergency Management (KYEM). But, the Division of Water (KDOW) is comprised of unique expertise regarding dam safety, dam failure, and the mitigation of potential failure. Adding to the robust methodology that defines Kentucky's risk assessment is something that benefits all local jurisdictions of the Commonwealth of Kentucky and that likely would not be pursued without the interest and expertise of a statewide agency such as the Division of Water.*

Executive Summary

As the state's infrastructure ages, a quantifiable plan is necessary to communicate the risks due to dam failure and identify mitigation opportunities and alternatives. Dam failure has been identified as one of the major natural hazards in the State Hazard Mitigation Plan (SHMP). The major tenets of this plan will better serve dam owners, citizens, local governments, and emergency response personnel by enhancing the risk assessment and mitigation strategies outlined in the SHMP and communicating them to a wide audience throughout the Commonwealth. By creating a more holistic and specific view of dam-related risks, this plan provides an opportunity to enhance the applicability and implementation of the SHMP and regional mitigation plans.

Dams have many beneficial uses throughout the Commonwealth including flood control, water supply, and recreation. However, dams may pose a significant hazard when risks are introduced through development downstream or as their components age. The plan provides an opportunity to better understand the risks that dams pose and to identify cost-effective options to reduce risk.

This plan integrates accepted methodologies from the scientific and emergency response and management community to gain a better understanding of the social and economic factors regarding dam failures. These methodologies provide a means for the Kentucky Division of Water (KDOW) to modernize its Dam Safety program in order to enhance sustainability and resilience for communities throughout the Commonwealth. KDOW has created applicable products that are dynamic and easily understood that encourages dam owners and affected communities to be part of the solution to reducing risk.

This plan was created in collaboration with Kentucky Emergency Management (KyEM) and the Federal Emergency Management Agency (FEMA) through a Hazard Mitigation Grant Program (HMGP) award as part of FEMA DR 1818 recovery.

Introduction

I-1 Purpose

Dams have many beneficial uses throughout the Commonwealth including flood control, water supply, and recreation. Dams are dynamic systems that require proper design, maintenance, and operation. Often, dams are designed for an intended purpose that changes over time. Dams may pose a significant risk when their components age and begin to fail, their intended uses change, and when unchecked development occurs downstream. When these risks are introduced either through deliberate or inadvertent actions, the consequences may be catastrophic should a dam failure occur. For these reasons, the Kentucky Division of Water (KDOW) has a dedicated Dam Safety program that has been established by state statute (KRS 151).

Most dam failures occur due to flooding events that cause overtopping of the dam. Other factors that may cause a dam to fail include foundation defects, internal erosion caused by seepage (piping), and inadequate maintenance. Regardless of the manner in which a dam failure may occur, communities and dam owners must be prepared to deal with the after effects.

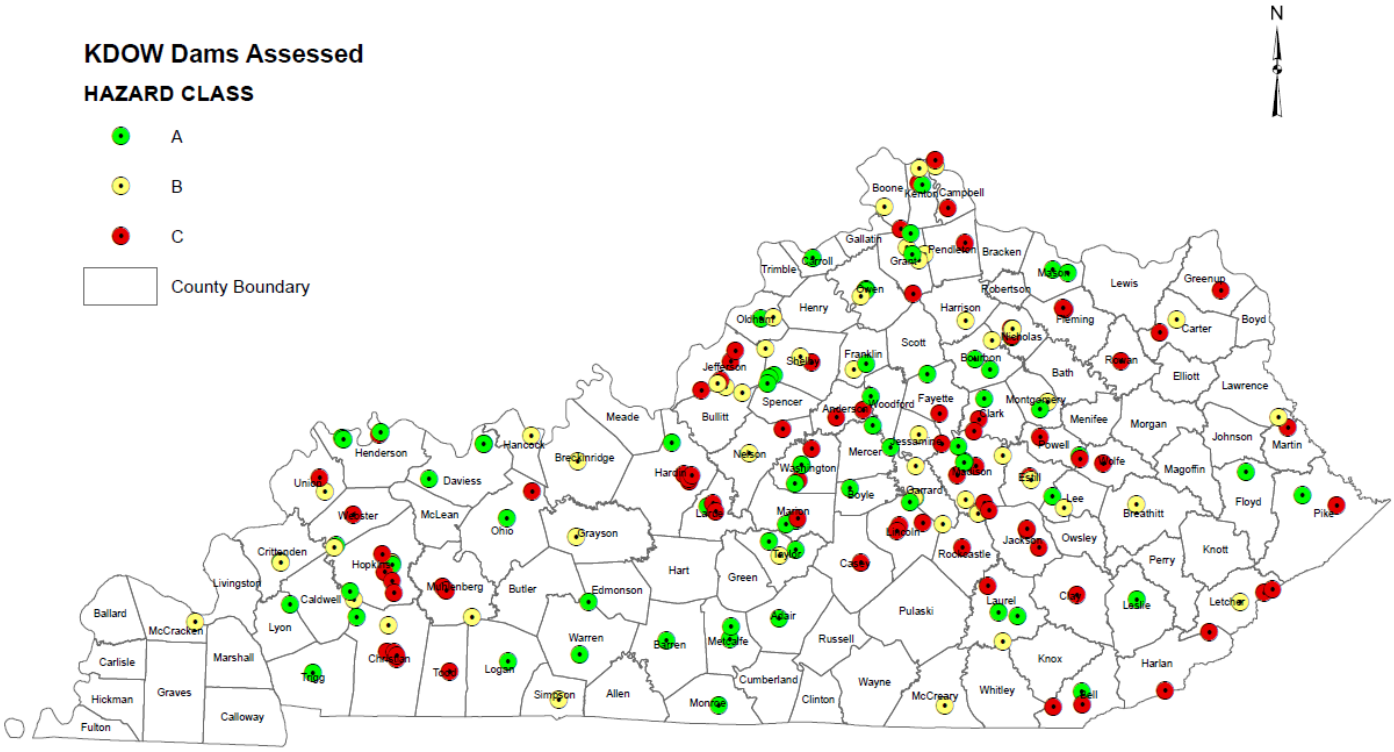
The Kentucky Dam Safety Mitigation Plan serves as an opportunity to better understand and assess the risks associated with dam failures in the Commonwealth. By modernizing its approach to characterizing, assessing and ultimately managing Dam Safety, KDOW created this plan as a tool to better manage resources and communicate the inherent risks of dam failures.

This plan addressed State and Local Government owned dams; approximately 200 dams within Kentucky's Dam Safety regulatory program (20% of the KDOW inventory). During the development of this plan, 3 dams were removed from the KDOW regulated dam inventory due to those dams not meeting regulatory requirements. As such, this plan assessed 197 dams. This plan has developed a model for 1) expanding the Commonwealth's capability to address flood and seismic risks associated with dams 2) effectively assess, communicate, and mitigate the risks associated with dams, and 3) develop strategies to mitigate identified risks that can be incorporated in the both the state and local hazard mitigation planning process. Key tasks to be completed as part of this project include:

1) Data Gathering, Field Reconnaissance, and Investigations
2) Dam Risk Assessment
3) Mitigation Alternative Analysis
4) Simplified Emergency Action Plans (sEAPs)
5) Seismic assessment
6) Catastrophic Long-Term Recovery Plans
7) Expanded Dam Safety Outreach and Education

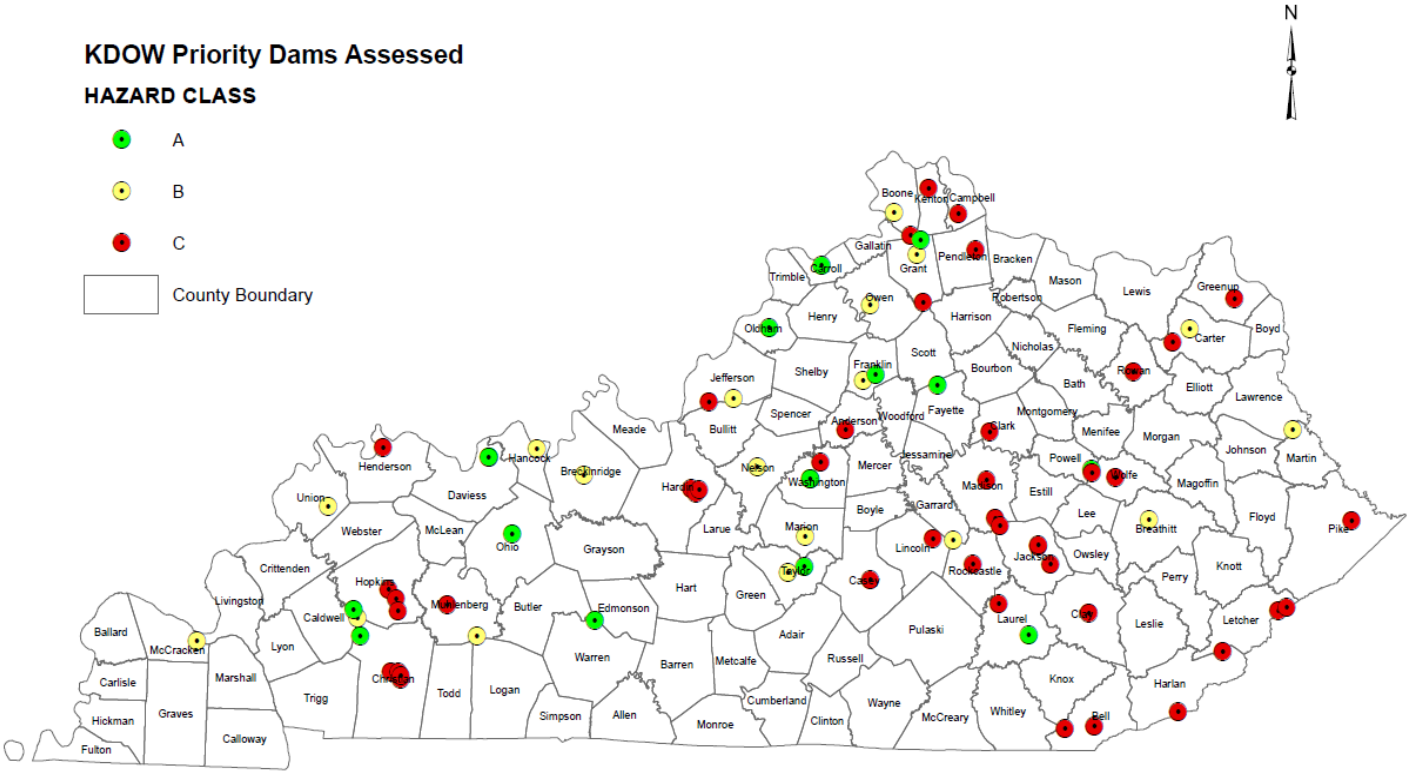
The tasks above were completed as part of a Hazard Mitigation Grant Program (HMGP) grant award from FEMA and administered by Kentucky Emergency Management (KyEM). The dams assessed in this plan are indicated in Figure I-1.

Figure I-1. Dams assessed as part of the Kentucky Dam Safety Mitigation Plan (197 total).



While the overall goal was to characterize and assess approximately 200 State and locally owned dams in this plan, a subset of 78 priority dams was identified by KDOW to receive more in depth risk assessment, mapping and mitigation alternative analysis (Sections 2 and 3). Simplified Emergency Action Plans (sEAPs) were created for each of these 78 priority dams (Section 4). Seismic assessment was conducted on a subset of 44 dams in the high risk seismic zones of Kentucky (Section 5). Additionally, Catastrophic Long Term Recovery Planning (CLTRP) documents were created for 10 of the 78 priority dams (Section 6). The priority dams identified in this plan may be found in Figure I-2.

Figure I-2. Priority dams where in more in depth mitigation screening, risk assessment, etc. occurred



This plan provides the basis to serve as a screening tool to better characterize a large portion of Kentucky's regulated dams in a synergistic manner to KDOW's regular dam inspections. The results of this plan may be used by KDOW to prioritize future dam improvements and mitigation measures. Additionally, this plan has a direct tie in with FEMA's Risk MAP program. Risk MAP (Mapping, Assessment, and Planning) carries a dam safety component with it; many of the products created as part of this plan are complementary to the flood risk datasets and products present in Risk MAP.

I-2 Dam Definition

A dam is defined by KRS 151 as any structure that is 25 feet in height, measured from the downstream toe to the crest of the dam, or has a maximum impounding capacity of 50 acre-feet or more at the top of the structure. Structures that fail to meet these criteria but have the potential to cause significant property damage or pose a threat to life in the downstream area are regulated in the same manner as dams. All structures except federal dams and those permitted by the Division of Mine Reclamation and Enforcement fall under the purview of the Kentucky Division of Water (KDOW).

I-3 Dam Classifications

High Hazard Dam (C) - Structures located such that failure may cause loss of life or serious damage to houses, industrial or commercial buildings, important public utilities, main highways or major railroads.

Moderate Hazard (B) - Structures located such that failure may cause significant damage to property and project operation, but loss of human life is not envisioned.

Low Hazard (A) - Structures located such that failure would cause loss of the structure itself but little or no additional damage to other property.

I-4 KDOW Dam Safety Program

There are 962 active dams (181 high hazard – Class C; 167 moderate hazard – Class B; 614 low hazard – Class A) regulated by KDOW in the Commonwealth. Additionally, approximately 62 dams remain in the KDOW dam inventory but are no longer active due to being breached, drained or removed from the KDOW dam inspection rotation. The Dam Safety Section within the Water Infrastructure Branch of KDOW inspects approximately 300 dams per year. In determining the frequency of inspection of a particular dam, the cabinet takes into consideration the size and type, topography, geology, soil condition, hydrology, climate, use of the reservoir, the lands lying in the floodplain downstream and the hazard classification of the dam. High- and moderate-hazard dams are inspected every two years. Low-hazard dams are inspected every five years.

The KDOW Dam Safety staff consists of four engineers and a supervisor that is a registered Professional Engineer (P.E.) in Kentucky. Dam Safety staff conducts inspections on prioritized dams each year that includes review of pertinent documentation, visual inspection and a follow up report that outlines observations, identifies deficiencies and proposes remedial measures, if required.

I-5 Project Team

As the sub-applicant for the HMGP grant, KDOW created a Project Team consisting of technical experts from the Dam Safety and Floodplain Compliance Section within the Water Infrastructure Branch, Risk MAP personnel from the Watershed Management Branch, the KDOW Director's Office and Stantec Consulting Services, Inc. to complete this plan. The KDOW technical experts provided guidance and input based on the considerable knowledge and experience with dams throughout the Commonwealth; Stantec served as the primary consultant for the mapping and engineering tasks required by the plan. Throughout the development of this plan, KyEM was consulted and required quarterly reporting was submitted to KyEM and FEMA.

I-6 Plan Outline

The Dam Safety Mitigation Plan integrates KDOW's dam-related expertise with risk assessment methodologies to build a comprehensive evaluation of the dams addressed by this plan. The plan contains seven sections, plus appendices:

1.0 Data Gathering Field Reconnaissance, and Investigations
2.0 Dam Risk Assessment
3.0 Mitigation Alternative Analysis
4.0 Simplified Emergency Action Plans
5.0 Seismic Assessment
6.0 Catastrophic Long-Term Recovery Plans
7.0 Expanded Dam Safety Outreach and Education

A brief description of the sections in the Dam Safety Mitigation Plan is as follows:

1.0 Data Gathering, Field Reconnaissance, and Investigations

Section 1 provides a description of the data analysis and field work that was conducted as part of this plan. Several tools were created in order to facilitate dam inspections and digital archives were created. This task served as the building block for the remainder of the tasks in the plan. For this task, 197 dams were assessed.

2.0 Dam Risk Assessment

Section 2 outlines the methodology that was utilized to perform a risk assessment for 78 dams as outlined in the scope for this plan. Several methodologies were assessed; KDOW chose the methodology that was most applicable to its current dam-related activites and available data.

3.0 Mitigation Alternative Analysis

Section 3 outlines mitigation alternative analysis was performed for the 78 dams where the risk assessment was conducted. This analysis includes an overview of the potential actions that may be undertaken to lessen and/or avoid dam failure risks.

4.0 Simplified Emergency Action Plans

Section 4 provides Simplified Emergency Action Plans (sEAPs) that were created for 78 dams using the routines and databases created from Section 2. These sEAPs provide dam owners a working document that may be completed so that emergency actions may be exercised in the event of a dam failure.

5.0 Seismic Assessment

Section 5 provides an assessment of 44 dams in the three active seismic zones in the Commonwealth. KDOW consulted with the Kentucky Geologic Survey regarding the methodology for this analysis so that the assessment was Kentucky-specific and not a generalized scheme used for the entire nation.

6.0 Catastrophic Long-Term Recovery Plans

Section 6 provides Catastrophic Long-Term Recovery Plans (CLTRPs) for a subset of 10 dams that assesses the recovery requirements should a multiple use dam fail. These documents provide dam owners a template to vet throughout their community that assesses many factors in dealing with the recovery of a dam failure

7.0 Expanded Dam Safety Outreach and Education

Section 7 provides an overview of the outreach and education opportunities that have been created as part of this plan including prototype Simplified Emergency Action Plans (sEAPs), prototype Catastrophic Long-Term Recovery Plans (CLTRPs), HAZUS outputs, and materials to increase the awareness of risks due to dam failure.

The deliverables for this plan are divided out by each section listed above. Included in most of the sections are appendices containing applicable data, results, and map products. Given the magnitude of the products created (approximately 12 GB), DVDs containing the digital deliverables are included.

I-7 Outcomes

The outcomes of this plan include:

1) To provide a plan to quantify, communicate, mitigate current and avoid future risk associated with dams.
2) To provide framework in which the public's awareness of the risks associated with living within the risk area of a dam failure will result in effective mitigation of current and future risk.
3) To develop processes for effectively conducting routine dam risk assessments and measuring reductions in risk.
4) To create partnerships that successfully leverages Kentucky Emergency Management and Dam Safety programs with FEMA's Mitigation and Dam Safety programs.
5) To integrate project outcomes into Kentucky's hazard mitigation plan and to use project results to effectively implement mitigation action and eliminate future risks.
6) Assist the Commonwealth of Kentucky in preparing standardized best practices for dam-related risk assessments, emergency action planning, catastrophic long-term recovery planning, and risk communication.
7) To educate local and state entities on the risks associated with living downstream of a dam.

2.0 Dam Risk Assessment

2.1 Background

In order to effectively characterize dam failure risks in the KDOW Dam Safety Mitigation Plan, several methodologies were applied to create a more holistic risk assessment. Inundation maps for all 197 dams were created using the Simplified Dam Break (SMPDBK) tool created by the National Oceanic and Atmospheric Administration (NOAA)/National Weather Service (NWS). As a result, the inundation maps were utilized to perform a HAZUS risk assessment on the 78 priority dams; the HAZUS analysis was used to provide information on the expected structure damage. Additionally, a Risk Assessment Spreadsheet Tool developed by the Natural Resource Conservation Service (NRCS) was utilized to assess the risk of the 78 priority dams based on their physical characteristics. Additional information on the risk assessment methodologies may be found below.

2.2 Inundation Mapping

The National Oceanic and Atmospheric Administration (NOAA)/ National Weather Service (NWS) developed the Simplified Dam Break (SMPDBK) model to predict downstream flooding due to a dam failure. This model was developed to estimate inundation areas without using more complicated and time consuming models such as NWS DAMBRK. The model is currently executed through a combination of two separate programs that enable the user to perform a dam breach analysis and generate output necessary for delineating inundation layers.

2.2.1 Methodology

SMPDBK is composed of two separate programs, GeoSMPDBK and DamAT. GeoSMPDBK is a GIS based preprocessing tool that utilizes the National Inventory of Dams (NID) database in conjunction with terrain data, cross sections, and stream centerlines to generate input data for the simplified dam breach analysis tool, DamAT (*GeoSMPDBK: Instructions*, September 27, 2011). DamAT is the tool that executes SMPDBK and performs post-processing (*Quick User Guide for Dambreak Application – Stand-alone version*, October 22, 2003). Stream centerlines can be copied from the NHD lines or generated by the user. Terrain data can be downloaded from various websites or may be obtained through a local agency. Cross sections are drawn by the user at key locations along the stream in which the analysis needs to take place and are drawn from left to right similar to the GIS tool GeoRAS. For each of the cross sections one can also specify ineffective flow areas (if known) by providing left and right ineffective flow area distances within the cross section attribute table. The NID dam database point layer is included in the GIS mxd and the tool pulls this information to generate the dam breach parameters.

To generate the input parameters for the DamAT program, the dam on the NID point file must be selected and the program executed via the button on the GeoSMPDBK toolbar. This generates two input text files, one for piping and one for overtopping. By default the program uses the NID information to calculate the breach parameters within the input file. These text files can be edited to reflect more updated data for the dam but would also require that the dam breach parameters be recalculated as well. In addition, the program allows the user to specify a specific height at each cross section for which the program will determine how long the water surface will be above that height. This is especially important in determining an approximate inundation time and duration for bridges or other structures that are located downstream of the dam. Once the input files are set they can be imported into the DamAT program which will generate the results.

2.2.2 Output

The output generated from the DamAT tool includes graphs and tables that summarize the results of the simplified dam breach analysis. The output tables provide results on max elevation, max depth, max depth time, and max flow for each cross section in the analysis. These tables can be used to create simplified inundation maps within GIS. The SMPDBK tool is also the basis for a new tool currently under development by FEMA; GeoDam Breach. Since the methodology in the NWS and FEMA tools are the same, the project team beta tested the GeoDam Breach product. The results of the inundation mapping may be found in Appendix 2-1 – Inundation Mapping. This appendix includes static map images and GIS data for the assessed dams.

2.3 HAZUS

HAZUS is a nationally applicable standardized methodology that contains models for estimating potential losses from earthquakes, floods, and hurricanes. HAZUS uses Geographic Information Systems (GIS) technology to estimate physical, economic, and social impacts of disasters. It graphically illustrates the limits of identified high-risk locations due to earthquake, hurricane and floods. Users can then visualize the spatial relationships between populations and other more permanently fixed geographic assets or resources for the specific hazard being modeled, a crucial function in the pre-disaster planning process.

2.3.1 Methodology

The dam failure depth grids developed in Section 2.2 were utilized in HAZUS-MH 2.1 to create a user defined flood risk for each dam assessed which provides a much more granular analysis than is present in the automated flood hazard identification routines inherent in HAZUS. The project team performed a default data analysis estimate of damage and loss using data provided with the HAZUS software for an overtopping scenario for the 78 priority dams. The results were based on an overtopping event and illustrate the census blocks affected by each dam inundation zone.

2.3.2 Output

HAZUS results may be characterized in many different ways based on the user's needs. For this plan, the flood loss estimation analysis for each dam is reported in tabular and spatial formats. The tabular loss reports characterize the direct economic losses for agricultural products, direct economic losses for buildings, a shelter summary, direct economic losses for utilities, and direct economic losses for vehicles. The spatial loss format is reported for each dam based on the total economic loss for buildings at a census block level. Losses were classified using the Natural Breaks (Jenks) method and depict the census blocks with low, moderate, significant, and high damage potential. Table 2.1 depicts the estimated HAZUS losses calculated for the 78 priority dams. The individual reports and the HAZUS native files (in .hpr format) for each dam may be found in Appendix 2-2 – HAZUS.

Table 2.1 Estimated HAZUS Losses for Priority Dams

KY Dam ID	Dam Name	County	Hazard Class.	Direct Economic Loss for Agriculture Products ($)	Building Loss ($)	Contents Loss ($)	Inventory Loss ($)	Relocation Loss ($)	Capital Related Loss ($)	Wages Losses ($)	Rental Income Loss ($)	Total Buildings Losses ($)	# of Displaced People	# of People Needing Short Term Shelter
KY0001	Des Islet Dam	Union	B	2657144	75000	58000	3000	0	0	0	0	136000	7	1
KY0004	North Fork Little River MPS No 4A	Christian	C	1272381	18300000	27990000	978000	14000	57000	340000	3000	47682000	1262	952
KY0007	Reformatory Dam	Oldham	A	364654	571000	643000	6000	0	1000	12000	0	1220000	12	0
KY0012	Scenic Lake Dam	Henderson	C	0	2721000	2213000	5000	8000	0	4000	1000	4952000	352	324
KY0014	Indian Lake	Hancock	B	0	60000	33000	0	0	0	0	0	93000	3	0
KY0015	Kingfisher Lake Dam	Daviess	A	208064	66000	40000	0	0	0	0	0	106000	10	0
KY0016	Carpenter Lake Dam	Daviess	A	250644	420000	365000	15000	1000	0	0	0	801000	75	65
KY0020	Marion County Sportsman Dam	Marion	B	418389	324000	405000	9000	0	0	0	0	738000	24	2
KY0029	Clements Lake Dam	Rowan	C	1023049	7986000	14631000	991	12000	40000	124000	1000	23785000	602	390
KY0032	Boltz Lake Dam	Grant	B	0	781000	532000	8000	0	0	0	0	1321000	30	4
KY0034	Valley Creek MPS No 4	Hardin	C	1230219	26169000	33578000	1067000	30000	62000	190000	7000	61103000	805	708
KY0036	Kincaid Creek Dam	Pendleton	C	1034286	1484000	1293000	44000	2000	9000	3000	1000	2836000	12	0
KY0037	Smokey Valley Dam	Carter	B	48947	111000	67000	1000	0	0	0	0	179000	8	0
KY0039	Greenbo Lake Dam	Greenup	C	0	906000	469000	0	0	0	0	0	1375000	56	7
KY0041	Campbell County Lake Dam	Campbell	C	0	2504000	1559000	4000	0	0	0	0	4067000	84	14
KY0042	Fishpond Lake Dam	Letcher	C	0	3018000	2574000	71000	2000	6000	13000	0	5684000	159	76
KY0043	Beech Creek Dam	Clay	C	0	10738000	24519000	288000	42000	109000	203000	12000	35911000	38	4

KY Dam ID	Dam Name	County	Hazard Class.	Direct Economic Loss for Agriculture Products ($)	Building Loss ($)	Contents Loss ($)	Inventory Loss ($)	Relocation Loss ($)	Capital Related Loss ($)	Wages Losses ($)	Rental Income Loss ($)	Total Buildings Losses ($)	# of Displaced People	# of People Needing Short Term Shelter
KY0044	Beshear Lake	Caldwell	C	1487541	3118000	2257000	17	6000	0	4000	1000	5403000	232	200
KY0045	Lake Sympson Dam	Nelson	B	323594	227000	141000	0	0	0	0	0	368000	7	0
KY0046	Cranks Creek Lake Dam	Harlan	C	0	131000	64000	0	0	0	0	0	195000	8	0
KY0049	General Butler State Park Lake Dam	Carroll	A	0	93000	293000	1000	0	0	0	0	387000	2	0
KY0051	Corinth Lake Dam	Grant	C	0	219000	183000	4000	0	0	0	0	406000	10	1
KY0052	Beaver Lake Dam	Anderson	C	0	463000	231000	0	0	0	0	0	694000	0	0
KY0053	Campton Lake Dam	Wolfe	C	15	87000	63000	4000	0	0	0	0	154000	4	0
KY0055	Bullock Pen Lake Dam	Grant	C	0	708000	407000	2000	0	0	0	0	1117000	25	1
KY0059	Elmer Davis Lake Dam	Owen	B	196278	169000	91000	1000	0	0	0	0	261000	8	0
KY0066	Lake Reba Dam	Madison	C	882091	997000	1748000	44000	0	2000	7000	0	2798000	51	5
KY0069	Natural Bridge State Park Lake Dam	Powell	A	0	99000	188000	1000	0	0	2000	0	290000	4	0
KY0083	Chenoa Lake Dam	Bell	C	0	225000	133000	0	0	0	0	0	358000	29	6
KY0088	Wood Creek Lake Dam	Laurel	C	0	495000	286000	2000	0	0	0	0	783000	26	3
KY0101	Renfro Dam	Rockcastle	C	85944	579000	763000	35000	0	0	6000	0	1383000	12	0
KY0103	Willisburg Lake Dam	Washington	C	888353	373000	235000	4000	0	0	2000	0	614000	20	0
KY0107	Hardinsburg FFA Camp Lake Dam	Breckinridge	B	51840	385000	295000	9000	0	0	0	0	689000	25	4
KY0108	Panbowl Lake	Breathitt	B	23504	4305000	5767000	58000	4000	15000	47000	1000	10197000	192	138

KY Dam ID	Dam Name	County	Hazard Class.	Direct Economic Loss for Agriculture Products ($)	Building Loss ($)	Contents Loss ($)	Inventory Loss ($)	Relocation Loss ($)	Capital Related Loss ($)	Wages Losses ($)	Rental Income Loss ($)	Total Buildings Losses ($)	# of Displaced People	# of People Needing Short Term Shelter
KY0109	Martin County Lake Dam	Martin	B	0	316000	165000	0	0	0	0	0	481000	24	1
KY0110	Mud River MPS 51	Muhlenberg	B	1577591	1730000	1150000	16000	1000	1000	2000	1000	2901000	60	27
KY0113	Elkhorn Lake Dam	Letcher	C	0	2902000	4066000	117000	1000	5000	15000	0	7106000	151	67
KY0114	Olive Hill Reservoir Dam	Carter	C	42578	2457000	1963000	9000	0	1000	6000	0	4436000	151	71
KY0117	Lake McNeely Dam	Jefferson	B	20822	3564000	2645000	13000	2000	0	0	0	6224000	137	70
KY0138	Spurlington Lake Dam	Taylor	C	880927	131000	105000	0	0	0	0	0	236000	14	0
KY0145	Lake Peewee Dam	Hopkins	C	868963	3827000	5824000	200000	17000	66000	31000	13000	9978000	85	30
KY0148	Loch Mary Reservoir Dam	Hopkins	C	29967	2549000	2455000	46000	1000	3000	10000	0	5064000	283	112
KY0155	Campbellsville Reservoir Dam	Taylor	B	1159627	3685000	3310000	84000	2000	5000	4000	0	7090000	140	79
KY0156	Mortons Gap Reservoir Dam	Hopkins	B	47520	1794000	1132000	7000	1000	0	1000	0	2935000	248	167
KY0157	Nortonville Lake Dam	Hopkins	C	24829	1943000	3529000	62000	1000	3000	19000	0	5557000	347	181
KY0158	Luzerne Lake Dam	Muhlenberg	C	1339622	1105000	2274000	71000	1000	1000	4000	0	3456000	80	31
KY0162	Shanty Hollow Lake Dam	Warren	A	199813	118000	101000	4000	0	0	0	0	223000	4	0
KY0173	Pennyrile Lake	Christian	A	0	20000	12000	0	0	0	0	0	32000	1	0
KY0176	North Fork Little River MPS No 4B	Christian	C	1238929	8552000	14564000	788000	6000	28000	82000	2000	24022000	262	95
KY0177	Valley Creek FRS 12	Hardin	C	353983	4063000	13505000	298000	13000	35000	369000	1000	18284000	151	52
KY0185	Univ. of KY Youth Camp	Hopkins	A	2477	0	0	0	0	0	0	0	0	1	0

KY Dam ID	Dam Name	County	Hazard Class.	Direct Economic Loss for Agriculture Products ($)	Building Loss ($)	Contents Loss ($)	Inventory Loss ($)	Relocation Loss ($)	Capital Related Loss ($)	Wages Losses ($)	Rental Income Loss ($)	Total Buildings Losses ($)	# of Displaced People	# of People Needing Short Term Shelter
KY0196	North Fork Little River MPS No 3	Christian	C	680381	12661000	19984000	766000	4000	46000	235000	0	33696000	869	659
KY0212	North Fork Little River MPS No 5	Christian	C	973560	9481000	15119000	778000	7000	28000	78000	0	25491000	339	167
KY0259	Mill Creek Lake Dam	Powell	C	32	2147000	2555000	41000	0	5000	34000	1000	4783000	43	6
KY0271	Tyner Lake	Jackson	C	19805	391000	199000	0	0	0	0	0	590000	30	2
KY0275	Cannon Creek Dam	Bell	C	0	1142000	634000	0	0	2000	0	0	1778000	64	9
KY0284	Valley Creek FRS No 3	Hardin	C	850251	11383000	30643000	812000	28000	72000	686000	8000	43632000	302	152
KY0288	Lake Washburn	Ohio	A	371603	32000	22000	0	0	0	0	0	54000	4	0
KY0307	Big Bone Lick State Park Lake Dam	Boone	B	0	73000	44000	0	0	0	0	0	117000	0	0
KY0372	Game Farm (Upper) Dam	Franklin	B	100228	30000	104000	0	0	0	16000	0	169000	4	0
KY0402	Priester Lake Dam	McCracken	B	11579	197000	467000	4000	0	0	0	0	668000	14	0
KY0508	McKee City Reservoir	Jackson	C	0	475000	401000	1000	0	0	0	0	877000	67	57
KY0536	Lloyd Dam	Grant	A	0	130000	103000	0	0	0	0	0	233000	11	2
KY0558	Kentucky Horse Park Dam	Fayette	A	16629	0	0	0	0	0	0	0	0	1	0
KY0571	Lincoln Homestead State Park Dam	Washington	A	170083	14000	6000	0	0	0	0	0	20000	1	0
KY0578	Kingdom Come State Park Dam	Harlan	C	0	2423000	3168000	163000	0	5000	11000	0	5770000	130	39
KY0593	Tom Wallace Lake Dam	Jefferson	C	3	422000	319000	0	0	0	0	0	741000	44	5
KY0764	Maywoods Lake Dam	Garrard	B	38237	165	307	0	0	3000	2000	0	477000	11	0

KY Dam ID	Dam Name	County	Hazard Class.	Direct Economic Loss for Agriculture Products ($)	Building Loss ($)	Contents Loss ($)	Inventory Loss ($)	Relocation Loss ($)	Capital Related Loss ($)	Wages Losses ($)	Rental Income Loss ($)	Total Buildings Losses ($)	# of Displaced People	# of People Needing Short Term Shelter
KY0766	Red Lick Creek FRS 12	Madison	B	0	579000	657000	0	0	0	85000	0	1321000	48	8
KY0769	Red Lick Creek MPS 1	Madison	B	0	2125000	2538000	14000	1000	0	222000	0	4900000	92	28
KY0820	Liberty Reservoir Dam	Casey	C	1935491	4540000	11524000	442000	8000	36000	347000	3000	16900000	114	46
KY1010	Banklick Creek FRS No 3	Kenton	C	335420	15775000	20972000	1387000	19000	68000	83000	4000	38308000	180	74
KY1035	Winchester Dam	Clark	C	116178	1397000	873000	7000	0	0	0	0	2277000	35	4
KY1037	Kentucky State University	Franklin	A	51356	34000	20000	0	0	0	0	0	54000	2	0
KY1110	Lincoln Homestead Dam No 2	Washington	A	160250	35000	15000	0	0	0	0	0	50000	1	0
KY1122	Pigeon Roost No 1	Jackson	C	13821	2041000	2491000	92000	2000	1000	5000	0	4632000	129	92
KY1167	Cedar Creek Dam	Lincoln	C	2075498	487000	292000	0	0	0	0	0	779000	33	5
KY1171	Grants Branch Impoundment	Pike	C	0	6810000	3804000	24000	1000	0	9000	0	10648000	251	109

2.4 NRCS Risk Assessment Spreadsheet Tool

The Natural Resources Conservation Service (NRCS) has created a spreadsheet tool that is designed to evaluate dams to assess risk. The spreadsheet is based on the U.S. Bureau of Reclamation's "Risk Based Profile System" developed for dam safety prioritization. This spreadsheet provides an overall "Total Failure Index" and "Total Risk Index" that are based on the potential for failure and the consequences of a failure. These values can be used to rank and compare the dam with other dams to prioritize funding and future studies. The project team used the NRCS Risk Assessment Spreadsheet Tool risk prioritization tool to perform an overall preliminary risk assessment of the 78 priority dams identified in the plan.

2.4.1 Methodology

The NRCS risk assessment spreadsheet consists of a series of questions about the dam. The questions are answered by the user based on available information for the dam and the spreadsheet calculates a "Total Failure Index" (based on the condition of the dam and its likelihood of failure) and a "Total Risk Index" (based on the consequences of a failure and the likelihood of failure). The process is relatively objective, which is important in order to be able to compare the dams to one another.

The spreadsheet contains five tabs: static, hydrologic, seismic, risk and consequences. The "static" tab considers the risk of a "sunny-day" failure due to the condition of the dam including the condition of the principal spillway, past reservoir filling history, seepage and deformation, foundation geology, and the design, construction and monitoring of the embankment. A series of yes or no questions is answered by the user utilizing available sources of information including dam specific information such as the last inspection report and as-built drawings, as well as publicly available data such as geologic quadrangle maps and soil surveys. The answers to the yes or no questions result in a point value (i.e. a "no" answer for a question may give a point value of 10). The points are summed to determine the "Static Failure Index."

The "hydrologic" tab considers the risk of a failure during a storm event based on the hydrologic capacity of the dam, and the geometric configuration of the spillways. The user enters values for each field based on available data (including previous hydrologic & hydraulic analyses) and an overall "Hydrologic Failure Index" is computed.

The "seismic" tab considers the proximity of the dam to seismic zones and the potential for liquefaction of the dam foundation. The user enters values based on as-built drawings or publicly available datasets such as seismic zones and geologic quadrangle maps. For this tab a "Seismic Failure Index" is computed.

The "risk" tab calculates the "Total Failure Index" and the "Total Risk Index." The "Total Failure Index" is the sum of the three failure indices (static, hydrologic, and seismic). The maximum amount of points for both the static and hydrologic failure indices is 300. The maximum for the "Seismic Failure Index" is 100. Therefore, the maximum "Total Failure Index" that can be calculated is 700. A higher risk index number corresponds with a higher risk of failure. For the "Total Risk Index" the user enters the estimated population at risk and a "fatality rate" (based on warning time, the community's understanding of evacuation procedures, and the depth and velocity of a potential breach). The failure index for each scenario (static, hydrologic, and seismic) is multiplied by the fatality rate and the population at risk to come up with a risk index. These risk indices are summed to compute the "Total Risk Index." Because the failure index is multiplied by the population at risk to compute the risk index, there is no maximum value for the "Total Risk Index."

The final tab is a “consequences” tab which summarizes the risk indices and gives an overview of the dam being considered. Most of the data on this tab is not considered in the computation of the risk indices, but can be used to compare the different failure impacts of two dams with similar risk indices. This information can help the end user determine which dam is more of a priority in terms of funding or further analysis.

2.4.2 Output

The output of the spreadsheet consists of two indices, a “Total Failure Index” (based on the condition of the dam and its likelihood of failure) and a “Total Risk Index” (based on the consequences of a failure combined with the likelihood of failure). These numbers can be computed for all of the dams and used to rank the dams. This ranking can be used for risk prioritization to determine which of the priority dams are in most need of further analysis or potential rehabilitation measures. Tables 2.2 and 2.2 depict the “Total Failure Index” and “Total Risk Index” for each of the assessed dam. The results of the Risk Assessment Spreadsheet Tool are located in Appendix 2-3.

Table 2.2 Dams Ranking by Total Failure Index

KDOW Inventory Number	Dam Name	County	Dam Owner[1]	Hazard Class.	Passes X% of Design Storm[1]	Static Failure Index[7]	Hydrologic Failure Index[8]	Adjusted Hydrologic Failure Index[9]	Seismic Failure Index[10]	Total Failure Index[11]	Adjusted Total Failure Index[12]	Total Risk Index[13]	Ranked by Adjusted Total Failure Index[14]
KY0288	LAKE WASHBURN	OHIO	COMMONWEALTH OF KENTUCKY	A	88%	235	170	194	0	405	429	486	1
KY0372	GAME FARM (UPPER)DAM	FRANKLIN	COMMONWEALTH OF KENTUCKY	B	50%	146	135	270	0	281	416	295	2
KY0055	BULLOCK PEN LAKE DAM	GRANT	COMMONWEALTH OF KENTUCKY	C	29%	86	138	300	0	224	386	269	3
KY0558	KENTUCKY HORSE PARK DAM	FAYETTE	COMMONWEALTH OF KENTUCKY	A	100%	159	156	156	0	315	315	76	4
KY0148	LOCH MARY RESERVOIR DAM	HOPKINS	CITY OF EARLINGTON	C	45%	86	91	203	15	192	304	9072	5
KY0109	MARTIN COUNTY LAKE DAM	MARTIN	COMMONWEALTH OF KENTUCKY	B	43%	134	68	159	0	202	293	1091	6
KY0044	BESHEAR LAKE	CALDWELL	COMMONWEALTH OF KENTUCKY	B	84%	140	104	123	8	252	271	567	7
KY0012	SCENIC LAKE DAM	HENDERSON	COMMONWEALTH OF KENTUCKY	C	86%	224	14	16	30	268	270	4781	8
KY0764	MAYWOODS LAKE DAM	GARRARD	COMMONWEALTH OF KENTUCKY	B	114%	215	54	54	0	269	269	605	9
KY1037	KENTUCKY STATE UNIVERSITY	FRANKLIN	COMMONWEALTH OF KENTUCKY	A	157%	146	116	116	0	262	262	157	10
KY0001	DES ISLET DAM	UNION	COMMONWEALTH OF KENTUCKY	B	100%	142	78	78	30	250	250	300	11
KY0049	GENERAL BUTLER STATE PARK LAKE DAM	CARROLL	COMMONWEALTH OF KENTUCKY	A	200%	215	30	30	0	245	245	0	12

KDOW Inventory Number	Dam Name	County	Dam Owner[1]	Hazard Class.	Passes X% of Design Storm[1]	Static Failure Index[7]	Hydrologic Failure Index[8]	Adjusted Hydrologic Failure Index[9]	Seismic Failure Index[10]	Total Failure Index[11]	Adjusted Total Failure Index[12]	Total Risk Index[13]	Ranked by Adjusted Total Failure Index[14]
KY0185	UNIVERSITY OF KENTUCKY YOUTH CAMP DAM	HOPKINS	COMMONWEALTH OF KENTUCKY	A	263%	86	151	151	8	245	245	147	13
KY0176	NF LITTLE RIVER MPS 4B	CHRISTIAN	HOPKINSVILLE WATER ENVIRONMENT AUTHORITY	C	100%	165	67	67	8	240	240	6444	14
KY0177	VALLEY CREEK FRS 12	HARDIN	CITY OF ELIZABETHTOWN	C	107%	167	70	70	0	237	237	526	15
KY0004	N FORK LITTLE RIVER MPS NO 4A	CHRISTIAN	CHRISTIAN COUNTY SCD	C	100%	155	67	67	8	230	230	22184	16
KY0769	RED LICK CREEK MPS 1	MADISON	BEREA COLLEGE	C	52%	93	68	131	0	161	224	942	17
KY0114	OLIVE HILL RESERVOIR DAM	CARTER	CITY OF OLIVE HILL	C	96%	147	60	62	8	215	217	6482	18
KY1110	LINCOLN HOMESTEAD DAM NO 2	WASHINGTON	COMMONWEALTH OF KENTUCKY	A	214%	158	59	59	0	217	217	228	19
KY0053	CAMPTON LAKE DAM	WOLFE	CITY OF CAMPTON	C	100%	143	72	72	0	215	215	452	20
KY0766	RED LICK CREEK FRS 12	MADISON	RED LICK CREEK CONSER. DIST.	C	51%	97	60	117	0	157	214	707	21
KY0036	KINCAID CREEK DAM	PENDLETON	COMMONWEALTH OF KENTUCKY	C	93%	101	104	112	0	205	213	646	23
KY1010	BANKLICK CREEK FRS NO 3	KENTON	KENTON COUNTY FISCAL COURT	C	104%	146	67	67	0	213	213	10480	22
KY0162	SHANTY HOLLOW LAKE DAM	WARREN	COMMONWEALTH OF KENTUCKY	A	250%	157	54	54	0	211	211	317	24
KY0212	N FORK LITTLE RIVER MPS NO 5	CHRISTIAN	CHRISTIAN COUNTY SCD	C	97%	132	68	70	8	208	210	7831	25
KY0307	BIG BONE LICK STATE PARK LAKE DAM	BOONE	COMMONWEALTH OF KENTUCKY	B	71%	91	81	113	0	172	204	335	26

KDOW Inventory Number	Dam Name	County	Dam Owner[1]	Hazard Class.	Passes X% of Design Storm[1]	Static Failure Index[7]	Hydrologic Failure Index[8]	Adjusted Hydrologic Failure Index[9]	Seismic Failure Index[10]	Total Failure Index[11]	Adjusted Total Failure Index[12]	Total Risk Index[13]	Ranked by Adjusted Total Failure Index[14]
KY0275	CANNON CREEK DAM	BELL	COMMONWEALTH OF KENTUCKY	C	100%	122	67	67	15	204	204	5936	27
KY0536	LLOYD DAM	GRANT	COMMONWEALTH OF KENTUCKY	A	214%	137	63	63	0	200	200	0	28
KY0037	SMOKEY VALLEY DAM	CARTER	COMMONWEALTH OF KENTUCKY	B	50%	75	58	116	8	141	199	85	29
KY0284	VALLEY CREEK FRS NO 3	HARDIN	CITY OF ELIZABETHTOWN	C	100%	163	36	36	0	199	199	14119	30
KY0043	BEECH CREEK DAM	CLAY	COMMONWEALTH OF KENTUCKY	C	72%	120	57	79	0	177	199	1885	31
KY0107	HARDINSBURG FFA CAMP LAKE DAM	BRECKINRIDGE	COMMONWEALTH OF KENTUCKY	B	100%	168	29	29	0	197	197	414	32
KY0032	BOLTZ LAKE DAM	GRANT	COMMONWEALTH OF KENTUCKY	B	71%	73	88	123	0	161	196	289	33
KY0196	N FORK LITTLE RIVER MPS NO 3	CHRISTIAN	HOPKINSVILLE WATER ENVIRONMENT AUTHORITY	C	100%	113	75	75	8	196	196	15229	34
KY0402	PRIESTER LAKE DAM	MCCRACKEN	COMMONWEALTH OF KENTUCKY	B	236%	162	2	2	30	194	194	349	35
KY0051	CORINTH LAKE DAM	GRANT	COMMONWEALTH OF KENTUCKY	C	96%	154	37	38	0	191	192	430	36
KY0110	MUD RIVER MPS NO 51	MUHLENBERG	COMMONWEALTH OF KENTUCKY	B	114%	134	50	50	8	192	192	806	37
KY0108	PANBOWL LAKE	BREATHITT	COMMONWEALTH OF KENTUCKY	B	229%	187	2	2	0	189	189	7740	38
KY0101	RENFRO DAM	ROCKCASTLE	COMMONWEALTH OF KENTUCKY	C	72%	169	14	19	0	183	188	7192	39
KY0105	FELTNER 4H CAMP LAKE DAM	LAUREL	COMMONWEALTH OF KENTUCKY	A	157%	133	53	53	0	186	186	307	40
KY0020	MARION CNTY SPORTSMAN	MARION	COMMONWEALTH OF KENTUCKY	B	164%	159	19	19	0	178	178	454	41

KDOW Inventory Number	Dam Name	County	Dam Owner[1]	Hazard Class.	Passes X% of Design Storm[1]	Static Failure Index[7]	Hydrologic Failure Index[8]	Adjusted Hydrologic Failure Index[9]	Seismic Failure Index[10]	Total Failure Index[11]	Adjusted Total Failure Index[12]	Total Risk Index[13]	Ranked by Adjusted Total Failure Index[14]
	S DAM												
KY0046	CRANKS CREEK LAKE DAM	HARLAN	HARLAN COUNTY FISCAL COURT	C	69%	133	20	29	15	168	177	1033	42
KY0045	LAKE SYMPSON DAM	NELSON	COMMONWEALTH OF KENTUCKY	B	100%	144	30	30	0	174	174	365	43
KY1171	GRANTS BR IMPOUNDMENT	PIKE	PIKE COUNTY FISCAL COURT	C	100%	159	13	13	0	172	172	7162	44
KY0117	LAKE MCNEELY DAM	JEFFERSON	COMMONWEALTH OF KENTUCKY	B	57%	63	61	107	0	124	170	74	45
KY1122	PIGEON ROOST NO 1	JACKSON	CITY OF MCKEE	C	103%	105	59	59	0	164	164	10627	46
KY0052	BEAVER LAKE DAM	ANDERSON	COMMONWEALTH OF KENTUCKY	C	100%	109	54	54	0	163	163	587	47
KY0007	REFORMATORY DAM	OLDHAM	COMMONWEALTH OF KENTUCKY	A	71%	52	76	106	0	128	158	230	48
KY0508	MCKEE CITY RESERVOIR	JACKSON	CITY OF MCKEE	C	107%	91	66	66	0	157	157	7724	49
KY0173	PENNYRILE LAKE	CHRISTIAN	COMMONWEALTH OF KENTUCKY	A	50%	30	62	124	2	94	156	268	50
KY0571	LINCOLN HOMESTEAD STATE PARK DAM	WASHINGTON	COMMONWEALTH OF KENTUCKY	A	271%	121	35	35	0	156	156	164	51
KY0014	INDIAN LAKE DAM	HANCOCK	COMMONWEALTH OF KENTUCKY	B	100%	120	29	29	0	149	149	89	52
KY0034	VALLEY CREEK MPS NO 4	HARDIN	CITY OF ELIZABETHTOWN	C	107%	84	65	65	0	149	149	25345	53
KY0578	KINGDOM COME STATE PARK DAM	HARLAN	COMMONWEALTH OF KENTUCKY	C	100%	116	15	15	15	146	146	1796	54
KY0016	CARPENTER LAKE DAM	DAVIESS	COMMONWEALTH OF KENTUCKY	B	157%	80	42	42	15	137	137	370	55
KY0138	SPURLINGTON LAKE DAM	TAYLOR	COMMONWEALTH OF KENTUCKY	A	114%	73	63	63	0	136	136	245	56

KDOW Inventory Number	Dam Name	County	Dam Owner[1]	Hazard Class.	Passes X% of Design Storm[1]	Static Failure Index[7]	Hydrologic Failure Index[8]	Adjusted Hydrologic Failure Index[9]	Seismic Failure Index[10]	Total Failure Index[11]	Adjusted Total Failure Index[12]	Total Risk Index[13]	Ranked by Adjusted Total Failure Index[14]
KY0145	LAKE PEEWEE DAM	HOPKINS	CITY OF MADISONVILLE	C	97%	114	10	10	8	132	132	1287	57
KY0015	KINGFISHER LAKE DAM	DAVIESS	COMMONWEALTH OF KENTUCKY	A	250%	80	14	14	30	124	124	149	58
KY0271	TYNER LAKE	JACKSON	JACKSON CO WATER DIST	C	110%	119	5	5	0	124	124	446	59
KY0088	WOOD CREEK LAKE DAM	LAUREL	COMMONWEALTH OF KENTUCKY	C	86%	118	5	6	0	123	124	959	60
KY0059	ELMER DAVIS LAKE DAM	OWEN	COMMONWEALTH OF KENTUCKY	B	71%	56	48	67	0	104	123	78	61
KY0820	LIBERTY RESERVOIR DAM	CASEY	CITY OF LIBERTY	C	97%	114	8	8	0	122	122	3678	62
KY0158	LUZERNE LAKE DAM	MUHLENBERG	CITY OF GREENVILLE	C	107%	101	5	5	15	121	121	653	63
KY0103	WILLISBURG LAKE DAM	WASHINGTON	COMMONWEALTH OF KENTUCKY	C	79%	109	8	10	0	117	119	84	64
KY0041	CAMPBELL CNTY LAKE DAM	CAMPBELL	CAMPBELL COUNTY FISCAL COURT	C	100%	114	3	3	0	117	117	1246	65
KY0259	MILL CREEK LAKE DAM	POWELL	COMMONWEALTH OF KENTUCKY	C	100%	106	10	10	0	116	116	2923	66
KY0042	FISHPOND LAKE DAM	LETCHER	LETCHER FISCAL COURT	C	100%	86	11	11	15	112	112	6770	67
KY0156	MORTONS GAP RESERVOIR DAM	HOPKINS	COMMONWEALTH OF KENTUCKY	C	179%	93	9	9	8	110	110	6237	68
KY0029	CLEMENTS LAKE DAM	ROWAN	COMMONWEALTH OF KENTUCKY	C	96%	81	11	11	15	107	107	34636	69
KY0155	CAMPBELLSVILLE RESERVOIR DAM	TAYLOR	CITY OF CAMPBELLSVILLE	B	107%	74	24	24	0	98	98	559	70
KY0083	CHENOA LAKE DAM	BELL	COMMONWEALTH OF KENTUCKY	C	97%	76	11	11	8	95	95	656	71
KY0157	NORTONVILLE LAKE DAM	HOPKINS	CITY OF NORTONVILLE	C	100%	80	6	6	8	94	94	324	72

KDOW Inventory Number	Dam Name	County	Dam Owner[1]	Hazard Class.	Passes X% of Design Storm[1]	Static Failure Index[7]	Hydrologic Failure Index[8]	Adjusted Hydrologic Failure Index[9]	Seismic Failure Index[10]	Total Failure Index[11]	Adjusted Total Failure Index[12]	Total Risk Index[13]	Ranked by Adjusted Total Failure Index[14]
KY0593	TOM WALLACE LAKE DAM	JEFFERSON	LOUISVILLE METRO PARKS	C	93%	80	9	10	0	89	90	854	73
KY1167	CEDAR CREEK DAM	LINCOLN	COMMONWEALTH OF KENTUCKY	C	93%	79	9	10	0	88	89	581	74
KY0039	GREENBO LAKE DAM	GREENUP	COMMONWEALTH OF KENTUCKY	C	100%	63	7	7	15	85	85	548	75
KY0066	LAKE REBA DAM	MADISON	COMMONWEALTH OF KENTUCKY	C	100%	67	9	9	0	76	76	1265	76
KY0069	NATURAL BRIDGE STATE PARK LAKE DAM	POWELL	COMMONWEALTH OF KENTUCKY	A	100%	22	50	50	0	72	72	756	77
KY1035	WINCHESTER DAM	CLARK	WINCHESTER MUNICIPAL UTILITIES	C	100%	60	2	2	0	62	62	270	78
KY0113	ELKHORN LAKE DAM	LETCHER	CITY OF JENKINS	C	93%	34	3	3	2	39	39	2375	79

1. Taken from KDOW Database
2. Items marked "Y" had little or no geotechnical information to support portions of the NRCS/USBR risk screening spreadsheet. In these cases, conservative assumptions were made.
3. Computed in the NRCS/USBR risk screening spreadsheet based on flood severity and whether or not a dam has an EAP.
4. Computed based on approximate inundation areas created using Simplified Dam Break and assumptions (discussed with KDOW in April, 2012) as follows:
   2.5 persons per home within the approximate inundation area
   4 persons per minor road within the approximate inundation area
   8 persons per major road within the approximate inundation area
   0.3 persons per parking space for businesses within the approximate inundation area
   0.1 persons per parking space for churches within the approximate inundation area
   0.75 persons per hospital bed for hospitals within the approximate inundation area
   0.15 persons per student in schools within the approximate inundation area
   0.75 persons per campsite in campgrounds within the approximate inundation area
5. Potential Lives Lost = Fatality Rate * PAR
6. Damages computed within HAZUS using approximate inundation depth grids and census block data.
7. Computed in the NRCS/USBR risk screening spreadsheet - represents the relative risk of a static failure of the dam.
8. Computed in the NRCS/USBR risk screening spreadsheet - represents the relative risk of a failure of the dam due to a storm event.
9. If the "Passes X% of Design Storm" is less than 100%, the Hydrologic failure was adjusted as follows:
   Adjusted Hydrologic Failure Index = Hydrologic Failure Index * (1/Passes X% of Design Storm) (Max value = 300)
10. Computed in the NRCS/USBR risk screening spreadsheet - represents the relative risk of a failure of the dam due to a seismic event.
11. Sum of the Static Failure Index, Hydrologic Failure Index, and Seismic Failure Index.
12. Sum of the Static Failure Index, Adjusted Hydrologic Failure Index, and Seismic Failure Index.
13. Computed in the NRCS/USBR risk screening spreadsheet (Total Risk Index * Fatality Rate * Population At Risk).
14. Dams were sorted by adjusted total failure index - dams with the highest adjusted total failure index are at the top of the list.

2.5 Results

The dams in this plan have been assessed for risk using nationally accepted methodology and using data that is much more granular than other state or regionally based mitigation plans. This comprehensive assessment will allow for KDOW to make informed decisions based on information compiled in this plan. The combination of economic and social factors used in this risk assessment is extremely valuable when considering potential mitigation options with limited funding.